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DIVISION OF ADMINISTRATION
DIVISION OF MINES AND GEOLOGY
DIVISION OF OIL, GAS AND GEOTHERMAL RESOURCES
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March 23, 1998

Larry Clark
Manager, Communications Division
County of Humboldt
825 5th Street
Eureka, California 95501

RE : INITIAL THREAT ASSESSMENT OF CLIFF RETREAT: ROUNDHOUSE CREEK ROAD, BIG LAGOON PARK SUBDIVISION, TRACT 22, BLOCK A , HUMBOLDT COUNTY, CALIFORNIA.

Dear Mr. Clark:

On February 16, 1998, Sandra Green of the Governor's Office of Emergency Services (OES), through Larry Clark of the Humboldt County OES, requested the Department of Conservation's Division of Mines and Geology (DMG) to perform an Initial Threat Assessment focused on rapid sea cliff retreat that occurred near Big Lagoon (OES Mission Number 98-CST7235). Big Lagoon is located approximately 6 miles north of the town of Trinidad and 1-1/2 miles north of Patricks Point State Park in Humboldt County, California (Sections 23, 24, T9N/R1W, HBM, Trinidad 7-1/2 Quadrangle). Between 2 and 50 feet of cliff (depending on location) had collapsed into the surf for a distance of approximately 1/2 mile. Part of one residence was undermined, as was the wood deck of another. The County's main concerns were rapid sea cliff retreat, imminent damage to property and residences, cliff proximity distances needed for "yellow- and red-tagging" of residences, and future construction set-backs. This report presents the observations, conclusions, and recommendations of DMG Associate Engineering Geologist James Falls regarding the cliff retreat.

FIELD WORK

On February 17, Falls and Todd Sobolik, Humboldt County Chief Building Official, conducted a helicopter reconnaissance to assess the limits of the cliff retreat. Falls developed a planimetric map of the site showing the eroded cliff edge relative to structures and property lines (see Figures 2-6). Falls, Clark and James Clark, Humboldt County Health Department representative, returned on February 22 (0.1 foot low tide) to collect additional data regarding further cliff retreat and cliff heights. Surf conditions were unsafe and only four cliff heights were measured on the northern end of the cliff.

LOCAL GEOLOGY

The threatened sea cliffs at Big Lagoon expose interbedded sandy and gravelly sediments that underlie an 83,000 year old uplifted marine terrace (Carver and Burke, 1992). The sediments were deposited in a shallow offshore marine environment very similar to that seen today off of Agate Beach. Northwestward movement of the Mendocino Triple Junction (the location where three sections of Earth's crust collide) near Petrolia has generated a 60 to 70 mile wide zone of faulting, folding, and uplift (Carver and Burke, 1992). This zone extends to the Big Lagoon area, where the sediments have been uplifted and tilted 3 to 4 degrees to the northeast.

The southern cliffs expose what appear to be two distinct units of sediment. The lower unit appears to be more erosionally resistant and forms near vertical cliffs. The upper unit appears to be less resistant and lies back at a lower angle (approximately 60 to 70 degrees). The lower unit appears to dive out of sight several hundred yards south of the eroding section of cliff. The upper unit underlies the threatened section.

The long-term retreat rate for this section of cliff was calculated at 2-1/2 to 3 feet per year in the late 1970's using historical aerial photographs and other archival records (Dr. Gary Carver, personal communication, 1998).

GENERAL OBSERVATIONS

The following observations refer to locations on Figure 1, Site Location Map; and Figures 2 through 5, Assessors Maps 1 through 4.

1) The recent erosion begins near parcel 15 and extends north approximately 1/2 mile (see Figures 1 through 3).

2) The cliffs south of parcel 15 appear to be stable and have a well-developed, densely vegetated buttress of debris along the base. Only minor erosion (3 to 5 feet) was observed at the toe of the buttress during the site visit.

3) The sand and gravel of the eroding cliff face typically stands between 70 and 90 degrees and appears to be lightly cemented with iron oxide (source of the reddish yellow cliff color). Overhanging banks of up to 4 feet were observed during the site visit and were associated with clusters of vegetation at the top of the cliff.

4) Individual failure masses were typically 3 to 8 feet thick and formed tabular bodies that extended along the cliff 20 to 70 feet. The failure surfaces were gently curved inward indicative that mode of failure was that of a sliding block that broke up as it dropped. Obvious jointing within the terrace deposits, i.e. parallel to the cliff, was not observed nor were topple failures observed during either of the site visits.

5) Cliffs up to 200 feet high exist on the southern end of Agate Beach near Patricks Point, and taper down to zero at the southwest corner of Big Lagoon (see Figure 1). Cliff height in the study area ranged from 25 to 90 feet.

6) Waves were breaking directly against the base of the cliff at high tide. Waves ran up to the base at low tide. Waves generally stopped short of the debris buttress at low tide south of the eroded section of cliff.

7) The section of cliff attacked by waves appeared to be a broad zone where the beach profile was 5 to 6 feet lower than neighboring sections. The beach profile returned to a higher elevation near the north end of the cliff (immediately beyond the former parking lot). Another low area was present approximately 1/2 mile farther north along the Big Lagoon sand spit, where waves appeared to be running farther up onto the beach. Waves were also breaking closer to shore in these low profile areas.

8) According to Todd Sobolik, large accumulations of slide debris and trees (landscaping) were present at several locations along the base of the cliff in the late afternoon of Monday, February 16. The base of the cliff was relatively clear of debris the following morning when the aerial reconnaissance was performed. No armoring by debris appeared to be taking place. The debris appeared to be removed by the surf soon after it was deposited.

9) Waves were directly approaching the coastline from the WNW during both site visits. Very little wave refraction appeared to be taking place around Patricks Point.

10) According to Gary Carver (personal communication, 1998) large sections of cliff failed during recent strong earthquakes. The locations and exact size of these failures was not available at the time of this writing.

11) The permeability of the terrace deposits was reported to be very good by several residents (several older houses used leachfields prior to the current sewer system). Evidence of perched ground water was not observed in the fresh cliff face.

CONCLUSIONS

Cliff Materials. The young marine terrace deposits are, by their nature, highly erodible materials. As noted earlier, the sand and gravel is lightly cemented together with iron oxide (source of the light reddish brown color). This allows the unit to stand nearly vertical to great heights, but allows it to be highly susceptible to wave erosion.

Over the past several decades, a buttress of debris from the cliff face has accumulated along the base. However, when directly attacked by the recent high waves, the buttress was quickly eroded, and the base of the cliff then came exposed to wave erosion once again.

The areas of recent erosion probably developed in response to large rip currents (rip tides) during periods of high surf. These currents develop in areas where water carried close to the shore by waves, accumulates, then moves back out to sea again in the form of a concentrated plume. These plumes are notorious hazardous to swimmers and are also very effective in pulling beach sediment offshore away from the active surf zone. As a result, the beach profile in the rip zone tends to be noticeably lower, and the water immediately offshore is deeper. The deeper water allows incoming waves to break closer to shore and deliver much more of their energy to the beach and cliffs. The locations of rip currents commonly shift over time, bringing new areas of cliff under attack. Once a section of cliff is undercut by the waves, a failure surface develops at the bottom and propagates upward until a slab of material "peels off". The fallen material is washed away, and the process starts again.

The driving force behind the wave action appears to have been a combination of high energy from the recent storms (many have been out of the North Pacific) and seasonally high tides (6 to 7 foot range). Other contributing factors could be: 1) storm surges (strong winds pushing a broad mound of water ahead of them), 2) warmer than usual offshore water related to El Nino (warmer water = less density = occupies more volume = higher sea surface elevation locally), and 3) low atmospheric pressure associated with the recent intense storms (water expands slightly = higher sea surface elevation). Storm surges and warm El Nino water offshore are probably the primary factors in this area.

Immediate Mitigation. The red and yellow tagging of structures by the county appears to be appropriate for the site conditions and observed failure rate. We understand that several other adjacent residences have been yellow tagged because of subsequent cliff retreat (see Figures 2 through 5).

Armoring of the base of the cliff with rip-rap would not be effective unless the structure was carefully designed and installed. The finished revetment would have to be very large and it would probably only last several seasons of heavy storms.

Public Safety. Subsequent cliff failures at Big Lagoon will continue to threaten property and structures in the immediate and foreseeable future. The average retreat rate determined by Carver is high (2.5 to 3 feet per year) and should be an important factor in future development planning.

At this time, the county is using a 20 foot setback to “yellow-tag” structures for limited occupancy and a 10 foot setback for “red-tagging” (immediate evacuation). These distances appear to be reasonable at this time, given the observed style of failure.

GENERAL RECOMMENDATIONS

1) The County of Humboldt should retain a consulting Certified Engineering Geologist or Licensed Civil Engineer with experience in coastal erosion processes to assist them in developing formal yellow and red tag distances for the existing residences.

2) The consultant should also provide input regarding future development setbacks from the cliff edge taking the cliff retreat rate, physical characteristics of the terrace deposits, and regional potential for violent seismic shaking.

References:

California Department of Natural Resources, Division of Forestry, 1954, black and white photographs, frames CVL-13N-106 through 108, nominal scale 1:12,000, dated August 3, 1954 .

Carver, G.A., and Burke, R.M., 1992, Late Cenozoic Deformation on the Cascadia Subduction Zone in the Region of the Mendocino Triple Junction in: Guidebook for the Field Trip to Northern Coastal California, Pacific Cell, Friends of the Pleistocene, June 5 through 7, 1992, pp. 31 - 63.

Cashman, P.H., Cashman, S.M., and Kelsey, H.M., 1982, Geology of the Rodgers Peak Quadrangle, Humboldt County, California: California Division of Mines and Geology Open File Report OFR-82-14 S.F., scale 1:24,000.

Humboldt County Assessor, 1962, black and white photographs, frames HCN-2 11B-10 through 12, nominal scale 1:12,000, dated August 22, 1962.

U.S. Forest Service, 1948, black and white photographs, frames CDF2-16-48 through 50, nominal scale 1:26,400, dated, June 23, 1948.

WAC Inc., 1984, black and white photographs, frames WAC-84C, 21-89 through 21-91, nominal scale 1:31,680, dated May 6, 1984.

WAC Inc., 1988, black and white photographs, frames WAC-88CA, 2-35 through 2-37, nominal scale 1:31,680, dated March 30, 1988.

James N. Falls, CEG 1696
Associate Engineering Geologist
Fortuna, California

Concur:

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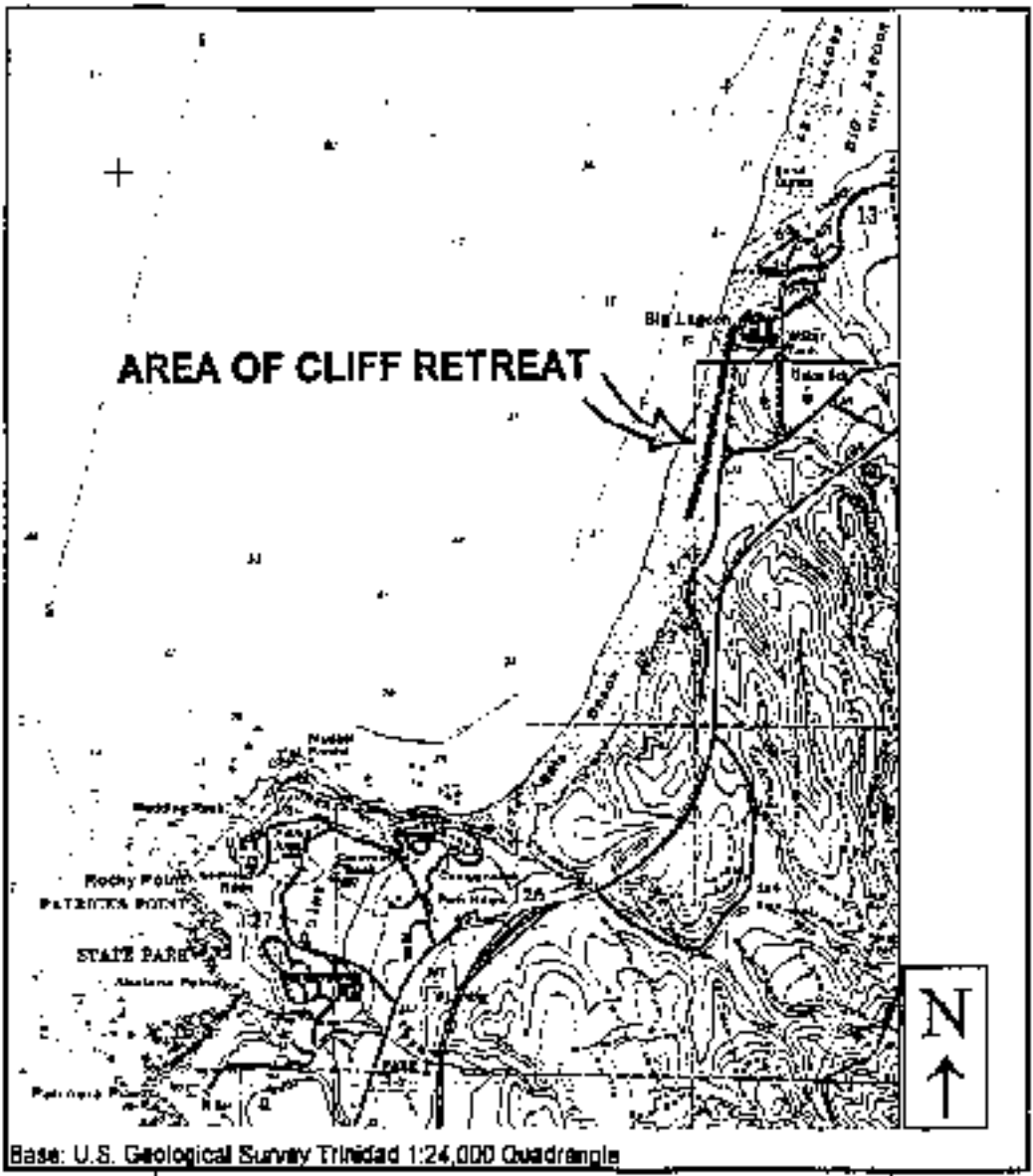
Date Trinda L. Bedrossian, CEG 1064
Supervising Geologist

Attachments

cc: Sandra Green
Jim Davis



Base: U.S. Geological Survey Trinidad 1:24,000 Quadrangle

Date: 3/8/98

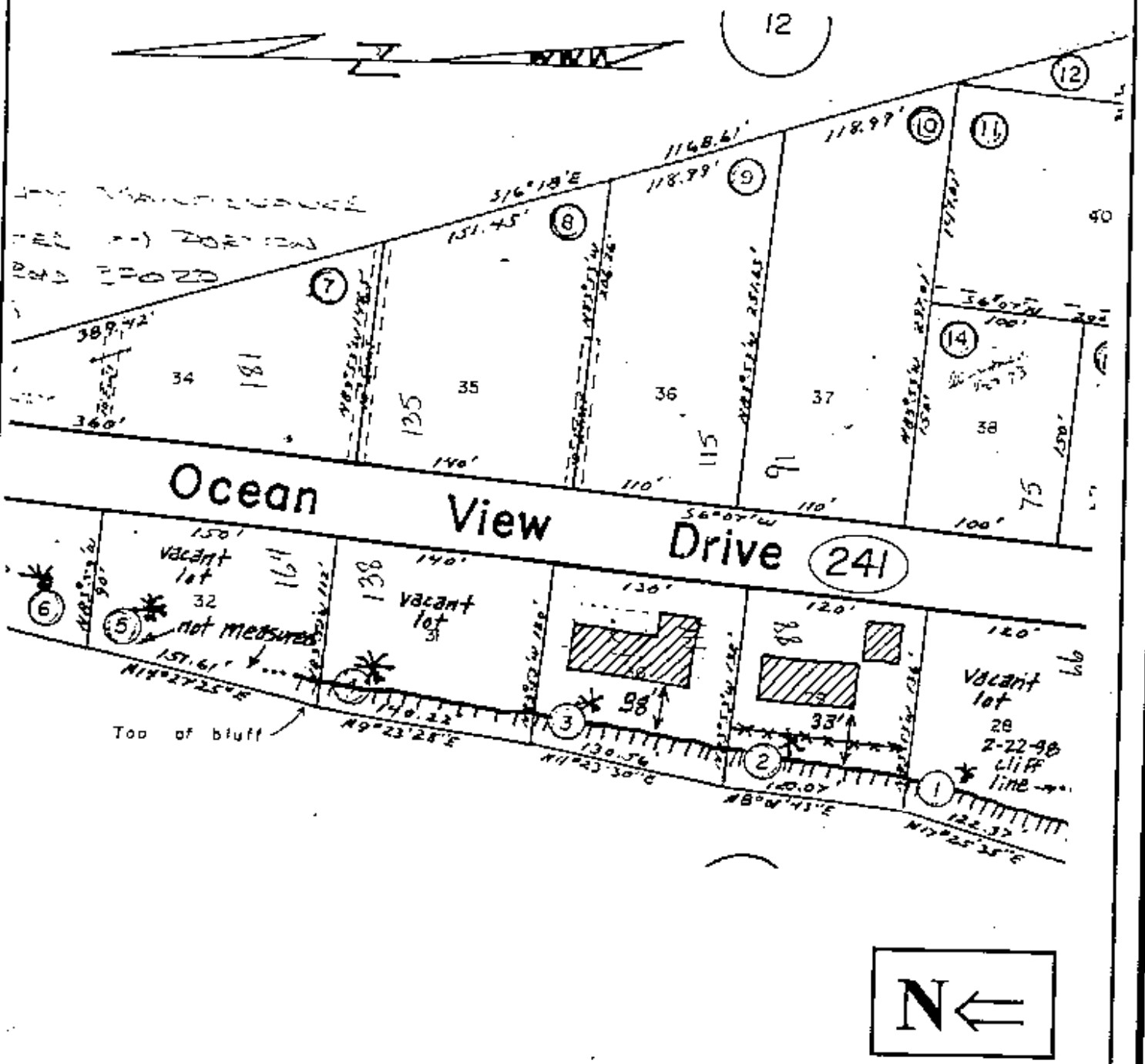
Scale: 1"=2,000'

Approved By: CDMG

Site Location Map
To Accompany
Initial Threat Assessment for
Big Lagoon Cliff Retreat

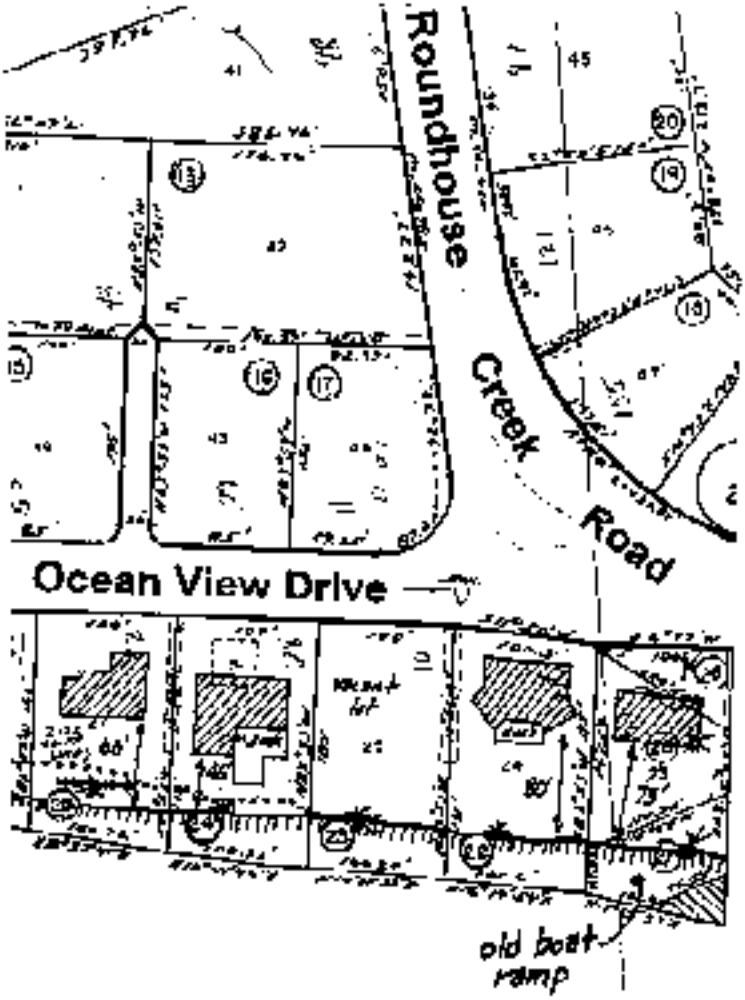
Figure

1



Base: Humboldt County Assessors Parcel Maps

ate: 3/6/98 cale: 1"=100' pproved By: CDMG	**Assessors Map 1** To Accompany Initial Threat Assessment of **Big Lagoon Cliff Retreat**	**Figure** **2**

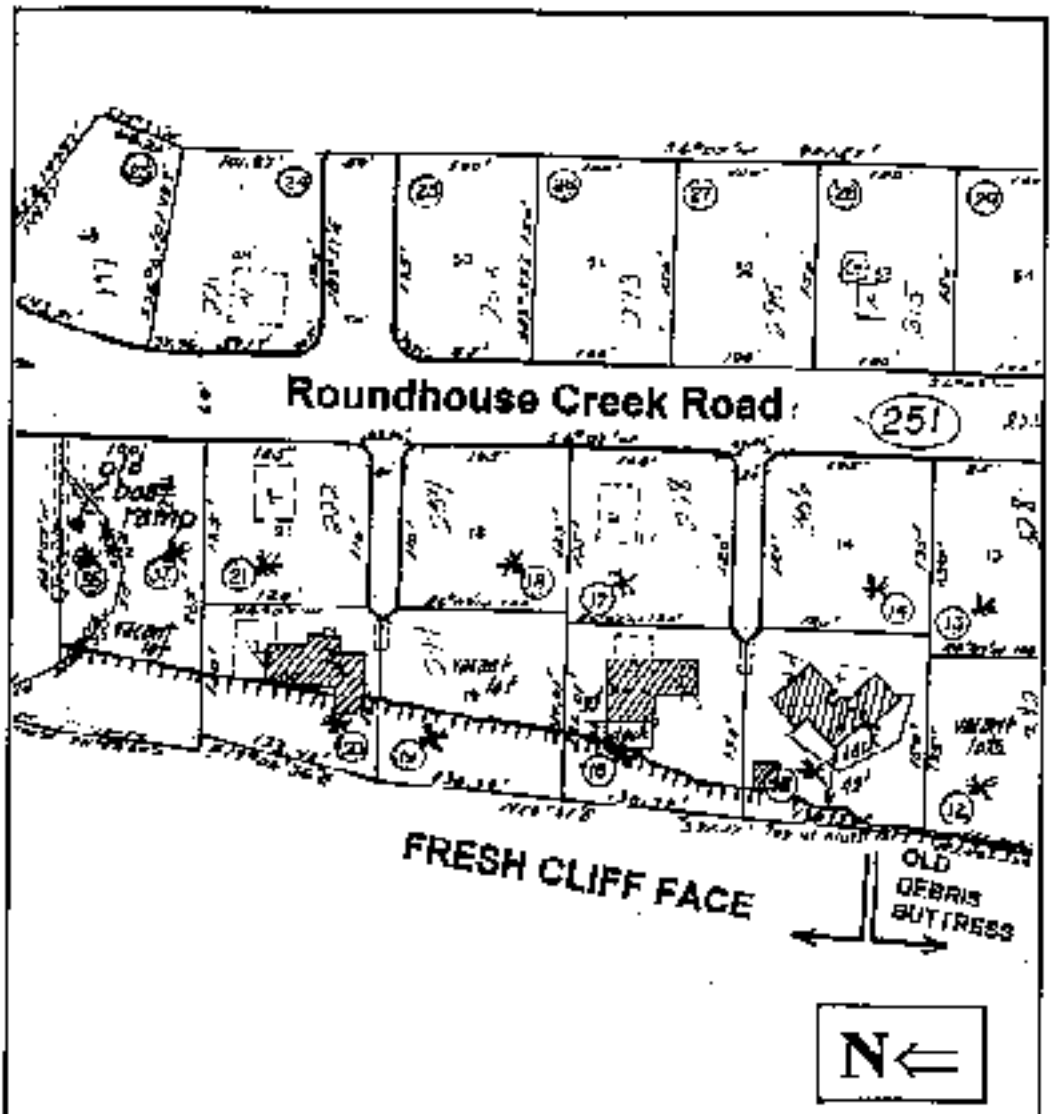


Base: Humboldt County Assessors Parcel Maps

Date: 3/5/98
Scale: 1"=100'
Approved By: CDMG

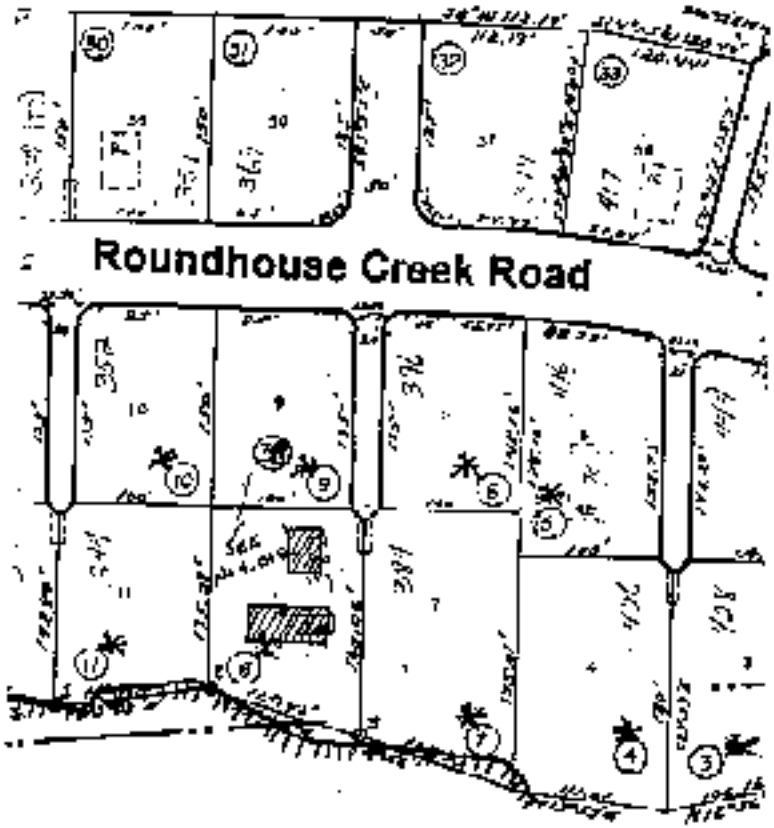
Assessors Map 2
To Accompany
Initial Threat Assessment of
Big Lagoon Cliff Retreat

Figure
3



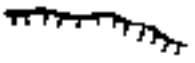
Base: Humboldt County Assessors Parcel Maps

Date: 3/6/98 Scale: 1"=100' Approved By: CDMG	**Assessors Map 3** To Accompany Initial Threat Assessment of **Big Lagoon Cliff Retreat**	Figure 4



Base: Humboldt County Assessors Parcel Maps

Date: 3/0/90 Scale: 1"=100' Approved By: CUMG	**Assessors Map 4** To Accompany Initial Threat Assessment of **Big Lagoon Cliff Retreat**	**Figure** 5



cliff face as of 2-17-98

property corner hub found in field

42'

closest distance between residence and top of cliff

(15)

lot number

fence line

N

Date: 3/6/98

Approved By: CDMG

Explanation of Symbols
To Accompany
Initial Threat Assessment of
Big Lagoon Cliff Retreat

Figure

6